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ABSTRACT

The problem investigated was to determine the effects of science process training, using two different inquiry strategies, on preservice teachers' knowledge of process skills, understanding of science, attitude toward science, attitude toward science teaching and attitude toward the inquiry strategy employed in the process training. The population used was 90 student teachers who selected grades 1-4 for assignment. The group was divided into three sections: the active-inquiry level, the vicarious-inquiry level and the control group. The criterion instruments that were employed were The Science Process Measure for Teachers, Test on Understanding Science, Attitude Toward Science and Science Teaching Scales, and Attitude Toward Method of Instruction Inventory. The results indicate the efficacy of process training in terms of improved process skill abilities. The study did not indicate any significant increase in the understanding of science nor any significant change in overall attitude toward science teaching as a result of training in process skills. (BP)

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THE EFFECT OF SCIENCE PROCESS TRAINING ON PRESERVICE ELEMENTARY TEACHERS' PROCESS SKILL ABILITIES, UNDERSTANDING OF SCIENCE, AND ATTITUDES TOWARD SCIENCE AND SCIENCE TEACHING

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Introduction

The substantial changes in elementary school science curriculum materials caused by the development activities of the 1960's have created a need for new approaches to teacher education. These needed new approaches are the result of the changing character of elementary science teaching. Traditionally the elementary science program to a considerable extent has followed secondary education's example in both philosophy and method of presentation. Lectures, demonstration and textbooks were the standard instructional techniques. Mastery of the basic science content was the main objective with memorization and recall the keys to student success. Science was narrowly defined as a "body of knowledge" and it was the task of the schools to disseminate this knowledge.

This one dimensional model of science teaching and the related educational purposes have been challenged by a more dynamic and realistic view of science and science educational objectives. The writings of scientists and educators such as Conant (1964) and Schwab (1962) present science as a procedure of inquiry or process as well as an organized body of subject matter.

The process aspect of science has received a great deal of attention in the National Science Foundation curriculum development projects. These curriculum writing projects brought together the cooperative efforts of scientists, educators and psychologists in developing new directions for elementary science. Attention to science as a process was a common objective of the curricula developed from these writing sessions.

The change in direction from content-oriented to more process-centered curriculum materials has not been followed by as substantial a change of emphasis in the preparation of elementary teachers. The need for preservice teacher education in the processes of science was

singled out by the American Association for the Advancement of Science Washington, D.C. Commission on Science Education (1970). In a set of Guidelines addressed to scientists, professors of education, college deans, and staff members concerned with teacher education, the Commission described the skills which teachers will need to teach modern science at the elementary level and the necessary revisions of college science courses. Guideline III under the heading "The Processes of Science" states that "the science experiences for elementary teachers should develop competence in inquiry skills or processes of scientific inquiry." Some of the process skills listed are observation, inference, measurement, classification and communication.

Raun and McGlathery (1970) suggest a lack of understanding of the nature of science to be the major reason that elementary school teachers indicate a dislike or fear of science. They further suggest that this lack of understanding is the result of exposure to the products of science and little or no exposure to the processes of science.

To date the literature expresses a strong need for teachers to be proficient in science process skills. There is a growing conviction, though as yet untested, that a teacher's attitude and confidence would be improved by proficiency in the process skills and that this would probably result in increased and improved science instruction. Little in the way of empirical research has been done to determine the possibility of improving process skills of preservice teachers and the results of any improvement on their attitude. This study is an attempt to address some aspects of this important area of research.

Statement of the Problem

The problem for investigation was to determine the effects of science process training using two different inquiry strategies on preservice teachers' 1) knowledge of the process skills, 2) understanding of science, 3) attitude toward science, 4) attitude toward science teaching, and 5) attitude toward the inquiry strategy employed in the process training.

The Sample

The available population for this study was comprised of all student teachers, enrolled in the undergraduate program at the University of Colorado, Boulder campus, who had selected a student teaching assignment in either grades 1, 2, 3, or 4. This available population was divided into thirds based on their undergraduate science grade point average. Thirty subjects from each of these three groups were then randomly selected and assigned to one of the three treatment levels. This selection procedure provided a total of ninety subjects.

Treatment Levels

In an effort to improve the science process skill abilities of preservice teachers, two treatments employing two different inquiry strategies were administered. The treatment levels are listed below.

1. The Active-Inquiry Level. Subjects in this group were trained in process skills using a manipulative, "hands-on" approach. Science materials were provided and used by the students in inquiry investigations.

2. The Vicarious-Inquiry Level. Subjects in this group were trained in process skills using an inquiry strategy but with out student manipulation of science materials.

3. The Control. This group of subjects spent approximately the same amount of time in neutral activities.

Design and Procedures

The basic framework for this study is a 3 x 3 factorial design. The two independent variables are (1) science grade point average having three levels designated high, medium and low, and (2) treatment with the three levels being active-inquiry, vicarious-inquiry and control. Figure 1 illustrates the 3 x 3 factorial design.

	Process Active	Process Vicarious	Control
High sci. GPA			
Middle sci. GPA			
Low sci. GPA			

Figure 2. Experimental Design

Using Campbell, Stanley (1971) notation, the basic design of this study can be diagrammed as follows:

R X_1 O_1 O_2 O_3 O_4
R X_2 O_1 O_2 O_3 O_4
R X_3 O_1 O_2 O_3 O_4

As previously stated, the levels of treatment are:

X_1 The Active-Inquiry treatment level

X_2 The Vicarious-Inquiry treatment level

X_3 The Control treatment level

The Criterion measures are:

O_1 Measure of Process Ability

O_2 Test on Understanding Science

O_3 Scales of Attitude Toward Science and Science Teaching

O_4 Questionnaire on Method of Instruction

Analysis of covariance, using number of undergraduate science courses as the concomitant variable, was performed on all data derived from the criterion measures. Where differences were found on the omnibus F test, the Newman-Keuls multiple comparison technique was employed.

Instrumentation

In order to collect data on the dependent variables, the following criterion instruments were employed:

1. The Science Process Measure for Teachers developed by AAAS Science - A Process Approach (1971) was used to measure preservice

teachers' ability in science process skills;

2. Test on Understanding Science published by Educational Testing Service was used to assess the preservice teachers' understanding of science;

3. Attitude Toward Science and Science Teaching Scales developed by Moore (1972) was used to assess the preservice teachers' attitudes toward science and toward science teaching; and

4. Attitude Toward Method of Instruction Inventory developed by the researcher was used to assess the preservice teachers' attitude toward the method of instruction employed in the study.

Results and Conclusions

I. Main Effect - Treatment

Science process training through both Active-Inquiry and Vicarious-Inquiry teaching strategies significantly improved preservice teachers' process skill abilities as measured by the Science Process Measure for Teachers. The two treatment levels, active-inquiry and vicarious-inquiry, scored higher than the control level on five of the seven subtests measuring the specific process skills. Differences between scores on three of these subtests were judged to be significantly different than the control. The basic skills measured by these three subtests are inferring, classifying, and using space/time relationships. No significant differences were found between the scores of the active-inquiry and the scores of the vicarious-inquiry groups on any process subtest.

It is concluded from these findings that training in the science process skills by either a vicarious-inquiry or an active-inquiry approach can be employed to improve preservice teachers' competence in certain process skills. The three skills in which training appears efficacious are inferring, classifying and using space/time relationships. No evidence could be found to support one inquiry method over the other in terms of either process skills or attitude toward the method of instruction. No treatment effect could be discerned on the dependent variables, attitude toward science and science teaching or on understanding science.

II. Main Effect - Science Grade Point Average

Undergraduate science grade point average was found to be related to the acquisition of the process skills as measured by the Science Process Measure for Teachers. Students who were in the high science grade point average level scored significantly higher than those in the low science grade point average level. Examination of the subtests for each of the seven basic skills revealed significant differences due to science grade point average on three of them: inferring, observing and using space/time relationships.

Science grade point average was related to understanding of science as measured by the Test on Understanding Science. The high science grade point average group scored significantly higher than did the low group.

Significance

Although teacher training in science process skills has been recommended by science educators and endorsed by the Commission on Science Education, little research has been conducted to validate the assumption that this training will produce the appropriate attitudes and understandings implicit therein. This study attempted to provide some empirical evidence to test these assumptions.

The results of this study indicate the efficacy of process training in terms of improved process skill abilities. The study did not indicate any significant increase in the understanding of science nor any significant change in overall attitude toward science and science teaching as a result of training in the process skills.

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